DOCUMENT RESUME

ED 319 617 SE 051 430

AUTHOR Workman, Mary Burke
TITLE The Effects of Grouping Patterns in a Cooperative Learning Environment on Student Academic Achievement.
PUB DATE May 90
NOTE 50p.; M.Sc. Thesis, Dominican College.
PUB TYPE Reports - Research/Technical (143) -- Dissertations/Theses - Master Theses (042)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Academic Achievement; Class Organization; *Cooperative Learning; *Educational Environment; *Geometry; Group Dynamics; *Grouping (Instructional Purposes); Group Instruction; High Schools; Mathematics Education; Qualitative Research; *Secondary School Mathematics; Small Group Instruction; Social Integration

ABSTRACT

This study investigated the effects of grouping patterns in a cooperative learning environment on the mathematics achievement of two high school geometry classes. Heterogeneous, homogenous, random, mixed gender and single gender grouping patterns were coordinated with six similar geometry topics and students were grouped accordingly for a period of 10 weeks. The t test was applied to pretests and posttests after each grouping pattern and only two grouping patterns showed significant results. However, the means, standard deviations, teacher observations, and student responses revealed other implications in relation to grouping and a favorable response to cooperative small group work. (Author)

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The Effects of Grouping Patterns in a Cooperative Learning Environment on Student Academic Achievement

Mary Burke Workman

A thesis submitted to the faculty of
Dominican College Department of Education
in partial fulfillment for the degree of
a Master's of Science in Education

May 1990

San Rafael, California

Running Head: GROUPING PATTERNS AND STUDENT ACHIEVEMENT

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Acknowledgements

Dr. Barry Kaufman, Education Department Chair at Dominican College in San Rafaél, California, served as advisor and consultant on this Master's thesis. The author is indebted to the Department of Education's faculty at Dominican College, particularly to Dr. Madalienne Peters for her patience, guidance, and counsel.

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About the Author

Mary Burke Workman received a B.A. Degree and a Multi-subject Credential from Dominican College in San Rafael, California. She has taught first, fourth, fifth, and sixth grades and continues to tutor students with learning disabilities.

Abstract

This study investigated the effects of grouping patterns in a cooperative learning environment on math achievement of two high school geometry classes. Heterogeneous, homogeneous, random, mixed gender and single gender grouping patterns were coordinated with six similar geometry topics and students were grouped accordingly for a period of 10 weeks. The t test was applied to pretests and posttests after each grouping pattern and only two grouping patterns showed significant results. However the means, standard deviations, teacher observations, and student responses revealed other implications in relation to grouping and a favorable response to cooperative small group work.

The Effect of Grouping Patterns in a Cooperative Learning Environment on Student Academic Achievement

Introduction

Cooperative Learning, which began in the 1960s, has recently increased in popularity because of its impact on student developmental learning and academic achievement. Cooperative learning is instruction methods in which students work together in small (usually mixed-ability) groups, each student contributing to and helping other group members understand and complete a given task or tasks. Years of research and many instructors, from the kindergarten to college level, support and advocate the use of cooperative small groups in the classroom. The use of small groups is one of the oldest, most researched, and most controversial issues in education (Slavin, 1987). How to group, when to group, and the purpose for grouping students for instruction are some of the questions still unanswered and under research. This study investigated different ways of grouping students for instruction (grouping patterns) and their effects on math (geometry) achievement at the secondary school level.

Statement of the Problem

Is there a relationship between different grouping patterns in a cooperative learning classroom and student academic achievement; and, if so, is one grouping pattern more effective than another? Cooperative learning improves student academic achievement but there are many variables to the cooperative learning goal structure. Any one variable or combination of variables could effect student outcomes. Grouping patterns is just one of the many which include; content area, teacher experience in cooperative learning, group size and flexibility, teacher interaction with students, group interaction, student accountability, and reward system. Because the basic component of cooperative learning is group work, it is important for educators to know if the way they are grouping students is having an effect on academic achievement. Should students be grouped by heterogeneous ability, or homogeneous ability, or random or gender? Does a particular grouping pattern effect the achievement of particular students? The purpose of this study was to see if grouping patterns played a significant role in effecting student academic achievement in a cooperative learning environment.

Rationale

Students differ in knowledge, skills, background, rate of learning and development. When teachers present a lesson to a class, each student should benefit from that lesson. For the sake of instructional efficiency, students are grouped. They should be grouped in such a way that the potential of every student is maximized. Those who do use small cooperative groups in instruction are looking for primarily one of two results; an improvement in student academic achievement or an improvement in student moral and social development (Noddings, 1989). Research shows that both occur. There is an increase in student academic achievement, an improvement in race relations, friendship patterns, student self-esteem, and also a growing awareness of, and participation in democratic processes (Noddings, 1989; Warring, Johnson, Maruyama, & Johnson, 1985). The student population is growing even more diverse today and teachers are still struggling to find effective ways to group students hoping to increase their achievement levels. If a relationship exists between grouping patterns in a cooperative classroom and student achievement, teachers should be aware of that relationship and of the consequences of selecting certain patterns on different types of students.

Background and Need

Throughout the history of education, teachers have used student groups in the classroom in an effort to differentiate instruction to meet the needs of an increasingly diverse student population. These groups have been small or large, heterogeneous or homogeneous, single-gender or mixed-gender, have had academic and/or social skills objectives, and have been formed by using random or structured selection methods (McCabe & Rhoades, 1988). In the early 1900s, as more poor and immigrant children began attending schools, many concerned educators, parents, and social psychologists felt that opportunity for learning could not be equal due to the mixture of abilities, ethnic backgrounds, and educational backgrounds in the classroom (Slavin, 1988). Thus began the tradition of homogeneous grouping in which students of like ability were placed in groups, thereby reducing heterogeneity, and enabling teachers to target student needs and abilities to effectively instruct them.

Heterogeneous grouping is still the most used pattern in a cooperative learning environment. In this pattern, students of mixed skills and aptitudes are grouped and encouraged to help other group members complete the group task, fostering student interdependence and interaction. Homogeneous and heterogeneous

grouping patterns arose out of the need to find more effective methods of instruction to improve student learning, and moral and social development. There are drawbacks and ethical questions surrounding both patterns. Placing students in low groups based on one homogeneous trait may mark them as low achievers, thereby lowering teacher expectations and dooming them to second-class instruction (Slavin, 1988). In placing students in heterogeneous groups, a teacher has not only to take the time to plan, form, and manage multiple groups, but must also be wary of the problem of student accountability. There are, in all probability, drawbacks to any grouping pattern but few studies exist on other patterns in a cooperative learning environment.

With the resurgence of the cooperative learning method and its positive effects on student self-esteem, critical thinking and social skills, more studies need to be conducted on the relationship between grouping patterns and student academic achievement. This study investigated homogeneous, heterogeneous, gender, and random grouping patterns.

Review of the Literature

In reviewing the literature, three characteristics emerged which helped to sort and select material relevant to this study.

These were the philosophy for using groups, the group goal structure, and whether grouping was between-class or within-class. First, each of these characteristics was more fully explained. Then, specific research studies that had particular variables common to grouping patterns and their effect on academic achievement were cited.

Small Group Instruction

Ever since John Dewey (1902) recommended that children be encouraged to work in small groups, considerable amounts of related research have been conducted, data have been compiled, and recommendations have been discussed. Dewey and other social psychologists, such as Vygotsky and Piaget believed that small group processes contributed to developmental learning. They were interested in social and moral behavior and emphasized the interdependence of learners (Noddings, 1989). Of several current researchers and educators who have the same philosophical beliefs, the most notable are: David Johnson, Roger Johnson, Fred Johnson, Shlomo Sharan, Noreen Webb, and Nel Noddings.

Robert Slavin belongs to another group of educators who feel that small groups should be used to strengthen specific skills of students and increase student academic achievement. Both groups have acknowledged that small group work improves academic achievement

and learning development; the disagreement between the two philosophies has been over which outcome deserves priority (Noddings, 1989).

Group Goal Structure.

Since the late 1970's, there has been an extensive amount of literature on group work, especially cooperative learning groups; so it was ironic to read read Glen Heathers (1969, p.568) critique on grouping, "Writing an epitaph for grouping may well be the task of the reviewer of research on grouping for the 1980 edition of this encyclopedia." To be fair to Mr. Heathers, his report on grouping was informative but was written at a time when individualized instruction was the main focus of educational reform.

The three instructional goal structures are individual, competitive, and cooperative. Much of the research compared the growth in achievement in cooperative small groups to that of competitive groups, and classes with individualized or whole class instruction. There was little research comparing the effects of cooperative learning grouping patterns on achievement. Heathers (1969) made an important point in his evaluation of new organizational or grouping patterns in research. He said that the purpose of most research should not only be to compare the new practices with the existing practices, but also to examine the relationship between

new practices and their outcomes. Although this was a study of grouping patterns in a cooperative environment, it is important to know the results of some of these other studies because they generally support the cooperative goal structure.

However, after Emmer (1984) observed 32 second and third grade classes for a year, he concluded that organizational variables such as individualized instruction, homogeneous grouping, and whole class instruction, could not predict achievement gains. He did not test cooperative small groups and, he could have used a more precise instrument for measuring academic achievement, other than teacher interviews and classroom observations. In another study, Dewar (1963) wanted to see whether children benefited more from within-class homogeneous grouping instruction or from the traditional whole class instruction. From an upper-middle class area in Jackson County, Kansas, he chose eight sixth grade classrooms whose teachers had volunteered to participate in the study. Based on the results of the Stanford Achievement tests, each experimental class was divided into three homogeneous groups. The control groups were also divided for purposes of statistical analysis only, not for instruction. The eight teachers were assigned at random to a control or experimental class. All used the same textbook materials and were given the same amount of instruction time. Dewar never specified

how many students were in each class or how long the study was conducted. Alternate forms of the Standford Achievement Test were given for the pre- and posttests. Statistically significant results revealed that homogeneous grouping for mathematics instruction benefited the high-achieving and the low-achieving groups in this study's population.

The majority of research shows that small cooperative group work is better than whole class or individualized instruction at improving student academic achievement. Many educators feel that cooperative learning should not replace any one method, but that it should be used with others in the classroom (McCabe & Rhoades, 1988; Sharan, Lazarowitz & Ackerman, 1980).

Between-class and Within-class Grouping.

Between-class grouping (school-level arrangements where students are assigned to classes), and within-class grouping (arrangements at a classroom-level where students are placed in groups) are the two major categories of grouping (Slavin, 1988). Between-class ability grouping is more likely to be by random assignment and the duration of the grouping period is much longer (quarter, semester, year). Research on between-class ability grouping differed from that on within-class ability grouping in many important ways. The focus of this study was on within-class grouping, but, information and results on some between-class studies follow.

Most of the research on grouping between 1917 and 1934 investigated the practicality and achievement gains of between-class homogeneous grouping. Billet (1932) reviewed 140 articles on homogeneous grouping and found that the quality of the research was irregular and the results inconclusive. Passow (1962) recorded his own results which confirmed Billet's conclusion. Out of 108 studies, 102 were uncontrolled and two were partly controlled. In the four thoroughly controlled studies, two favored homogeneous grouping, one did not, and one was uncertain. Of the 102 uncontrolled studies, 88 were favorable to between-class homogeneous grouping, four were unfavorable, and ten were uncertain. (Passow, 1962).

For the next 15 years, very few research studies were conducted. But, from 1950 to 1960, grouping research, including comparisons between heterogeneous ability grouping and homogeneous ability grouping at the school-level, burgeoned. Goodlad (1960, p.223) described this renewed interest best when he said, "Perhaps the most controversial issue of classroom organization in recent years is whether or not students of like ability should be grouped together for instructional purposes." In 1958, students were assigned to 8 heterogeneous and 11 homogeneous intermediate classrooms, based on their performance on a subtest of the Iowa Tests of Basic Skills. At the end of the study, other tests were also used to

assess student achievement; the Metropolitan Achievement Test and an end-of-the-year test constructed by the textbook publishers. There was no statement regarding the reliability or validity of any of these tests. The teachers all received the same training and were randomly assigned to one of the 19 classes. The researcher expected that the slow and fast learners would benefit the most from homogeneous grouping. The results were, that in the homogeneous ability classes, the fast learners benefited the most, the average may have, and the slow showed no difference. In the heterogeneous classes, the fast and the average did not learned any more than the lowest--they were kept within the group, solidified their own learning, but did not progress (Provus, 1960).

Research like this, set the tradition for widespread use of between-class homogeneous or heterogeneous grouping that still occurs today in many districts, especially at the secondary level. Most high schools are on a tracking system where students, based on prior achievement are placed in relatively homogeneous ability level classes; basic, regular, or honors. Some between-class homogeneous ability studies were done on the secondary level. The results were that 36 out of 51 studies showed that grouped students' achievement scores were higher; 14 out of the 51 showed higher achievement gains for ungrouped students; one study showed

no difference. Conclusions indicated that there was enough variation to show that factors other than grouping played a role in the outcome (Kulik & Kulik, 1982). Slavin (1987) did perhaps one of the best literature reviews on between-class ability grouping and its effect on achievement. Most between-class studies showed that there were few benefits for student achievement, although some claimed to have small positive achievement effects, mostly for high achievers at the secondary level.

The literature reviewed in the following section is an examination of the relationship of within-class grouping patterns in a cooperative learning environment to achievement. Most of the research on grouping patterns focused on heterogeneous ability groups compared with homogeneous ability groups in math or reading at an elementary level and very little dealt with grouping at the secondary level. Also, few studies investigated the effects of random or single-gender groups on student achievement. In examining gender differences, there was some indication that females prefer and perform significantly better in single gender cooperative groups (Noddings, 1989; Nowicki, Duke & Crouch, 1978; Owens & Barnes, 1982; Peterson & Fennema, 1985).

Wilkinson (1986) found the research on grouping to be divided into four points of view:

1. Sociological: Classroom organizational structures and their effects on student achievement--the consequences of grouping patterns.
2. Sociolinguistic: Use of language between and among groups in the classroom.
3. Process-Product: Teacher-student interaction and how those processes facilitated student achievement.
4. Cooperative learning: Effects of students working together in small groups.

Wilkinson's paper provided a very clear overview of research and theory on within-class grouping for instruction, including how groups are formed and managed, how students interact in groups, and how grouping effects students' achievement, with particular concern for low-achieving students. In sharp contrast with the sociological, sociolinguistic and process-product findings, Wilkinson noticed that students did not seem to be at a disadvantage when they participated in cooperative learning.

Numerous studies on the effects of cooperative groups were conducted which concentrate on skill acquisition and achievement (Aronson, 1978; DeVries & Slavin, 1978; Slavin, 1978). Other cooperative group studies (Johnson & Johnson, 1974; Sharan & Sharan, 1976) focused more on higher level process skills and student

behavior and interaction within groups. These studies involved mainly heterogeneous small groups. The researchers felt that a mixture of students and abilities was not only more democratic, but also more conducive to life in the real world, at work, and in the community. The Johnsons developed Group-Investigating (GI) which is similar to Sharan's Small Group Teaching (SGT). Both involve small heterogeneous groups which cooperate together in the classroom to gather information from a broad spectrum of information sources. Learning tasks are relatively complex, involving high-level cognitive processes. GI and SGT function very differently from the models of Aronson, Slavin, and DeVries.

Slavin's Student Teams and Academic Divisions (STAD), DeVries and Slavin's Teams-Games-Tournaments (T-G-T), and Aronson's Jigsaw are examples of Peer-Tutoring methods because they involve a combination of heterogeneous and homogeneous groups in which students teach other group members specific skills. In T-G-T, for example, students are usually heterogeneously grouped so that there is a mixture of ability levels, usually high achiever, middle achiever, and low achiever. If grouped for a vocabulary lesson, the high achiever teaches part of the vocabulary list to the other members in his or her group, the middle achiever teaches another part of the list to the group members, and the low achiever teaches the final part of the list. The heterogeneous groups then break up,

form homogeneous ability groups, and compete in a vocabulary game with all members on equal ability levels. Thus, a combination of heterogeneous and homogeneous grouping patterns are used for one task. Group rewards are also usually involved.

Research results of specific cooperative groupings showed that academic achievement, students' attitudes, and even ethnic relations improved when using these methods. In group investigation and peer tutoring approaches, group processes are activated to achieve different goals but both methods can be used in the classroom to meet the different needs of different students (Sharan, 1980).

Studies that dealt with random grouping patterns and its effect on achievement were not found. Only one study was discovered in which math achievement scores of randomly grouped students were compared with the scores of homogeneously grouped students. Although Eddleman (1971) formed her control group by randomly assigning students to groups, she assigned them to heterogeneous groups. She did not specify heterogeneous by ability, but her study was treated as one which compared homogeneous grouping to heterogeneous grouping and not to pure random grouping. Eddleman was also concerned about socioeconomic status and its effect on achievement and examined three elementary schools, each representing a high, middle, or low socioeconomic level. For nine weeks, 156 students in six math classes, two from each school, used the same materials and received

basically the same instruction. The same fifth grade arithmetic teacher at each school taught the heterogeneously grouped students in the control group and the homogeneously grouped students in the experimental group. The experimental class was homogeneously grouped based on achievement scores from Form B of the Intermediate Arithmetic Test of the Metropolitan Achievement Series, past performance in math, and teacher opinion. An alternate form of the pretest was administered for the posttest. Reliability and validity of the test was not stated. Eddleman found that significant differences in achievement gains were made by students at the high and low socioeconomic level but found no significant difference in achievement gains of students who were grouped homogeneously to those grouped heterogeneously.

Another study which stated similar results was done by Johnston (1973). Part of his complex study included a comparison between achievement scores of 30 homogeneously grouped (the control group) and scores of heterogeneously grouped first graders. Johnston stated that 99 students were used for the experimental group and that for math achievement the groups were differentiated heterogeneous by stratification using an arithmetic criterion test. The scores were ranked and three groups were formed but the number of students in each group is unclear. The study lasted for one school year. It was not indicated whether the same materials,

same teacher(s), and same basic instruction were being used for the experimental and control groups. The students were pretested using the 1957 edition of the California Achievement Test (CAT), Form W, and the Self Appraisal Inventory of the Instructional Objectives Exchange. The posttests were the same except Form X of the CAT was used. The mean and standard deviations from the pre- and posttests for all subgroups in each grouping pattern were compared using the t test. No significant difference was found in the achievement scores for students grouped homogeneously and those grouped heterogeneously.

Although no significant difference was found between heterogeneous and homogeneous grouping patterns in these studies, many researchers and educators, especially from the cooperative learning school, advocate the use of the heterogeneous grouping pattern. However, Wilkinson (1986) found that the most common basis for within-class grouping, particularly at the elementary level, was student ability and that most teachers created groups that were homogeneous with respect to student ability. Even when teachers considered other student characteristics, such as ethnicity, the homogeneous ability grouping pattern remained.

Grouping homogeneously or heterogeneously inevitably stirs up controversy. Teachers who use within-class grouping believe that in order for all group members to freely and equally participate,

the groups must be homogeneous by ability. They feel that in heterogeneous groups, members turn to the most academically able and concur that it is difficult to find materials that will promote contributions from all group members (Noddings, 1989). Webb (1982) discovered that average ability students in homogeneous ability groups had higher achievement scores than did average ability students in heterogeneous groups. In heterogeneous groups, the middle and low students showed no change, but the high ability students did the best. This contrasted with Taylor (1989), who found evidence that cooperative learning in small heterogeneous groups had great potential for raising the achievement level of all students. William Glasser, in a 1987 interview on how to improve the schools, stated that teachers should select the members of small learning groups and that the members should be of mixed ability. He added that team assignments should be ones that not just one of the students could easily do alone. Cooperative small group research is still being done with a focus on its effect on outcomes other than achievement, such as peer liking and influence, and cross-ethnic and cross-gender relationships. The grouping pattern most often used in these research studies is heterogeneous by ability. Even with the gender studies, students of different ability levels are grouped together instead of allowing all low ability students to be placed in one group.

Noddings (1989) cited several studies (Bunch & Pollack, 1983; Chipman & Wilson, 1985; Johnson & Stevens, 1985), which documented differences between females and males and their patterns of knowing and relating. Aiken (1986-87) investigated why the mathematical ability of boys is more advanced than girls by the end of high school when before they enter high school, it is not. In his review of the literature he found that men scored higher than women on geometry exams at the college level even when both came from the same high school and had similar math backgrounds. Some studies attributed the difference between genders in math ability and performance to heredity and environment. Some studies investigated other variables, like teacher-student interaction, reward structures, classroom organization and structure.

Schmuck and Egmond (1965), in their study of 18 elementary, 4 junior high, and 5 high school classes (N = 727 students), found that four non-academic variables influenced math performance of girls while only two did for boys. Perceived parental attitude toward school, perceived social class, perceived peer liking, and satisfaction with the teacher all were positively related to girls academic performance in the classroom. The academic performance of boys was associated with two variables, perceived group status and satisfaction with the teacher. The data were collected and

measured using rater/scorers. Analysis of rater reliability yielded 84% agreement between two raters. Separate chi square analysis at each grade level yielded significant and similar results. When boys scored low they scored low 81% of the time.

Michaels (1978) found that math performance of college females equaled that of college males only when different group and individual rewards were used within groups. Immediate value rewards other than grades were found to be positively associated with math performance of females. However, the generalizability of these findings to the typical classroom setting may be restricted because of a combination of factors. The subjects were college students who were gathered for a single session in a laboratory setting to perform one math task for a monetary reward. Michaels cited another study (Maccoby & Jacklin, 1974) which produced similar results.

Some educators and researchers found that cooperative small group work, while having no effect on boys mathematical achievement, improved girls performance and mathematical achievement scores. Single gender settings also had positive effects on achievement and participation of women in academic activities. By sixth grade math interest dwindled, and teachers found that allowing girls to work in all girl groups not only encouraged them, but also made

a difference in their achievement levels. (Johnson, Johnson, & Stevens 1985; Noddings, 1989; Schmuck, 1983).

One study found that some females showed their greatest achievement potential depending upon whether they were grouped to compete or cooperate, with males or females (Nowicki, Duke, & Crouch, 1978). Women's achievement level was higher when in a cooperative group with female members. Some women's achievement levels suffered when competing with men or working with men in cooperative groups. The subjects in this study totaled 160 white college students with a median age of 19. Sixty females volunteered from sororities while the other subjects were selected from a subject pool from a Psychology I course. The test used was the Adult Nowicki-Strickland Internal External Control Scale. The authors stated that satisfactory reliability and validity for use of this scale with this population was reported in Nowicki & Duke, 1974. The data was analyzed by using ANOVA.

Webb (1984) found no difference in achievement and interaction patterns in groups with equal numbers of females and males. However, in majority-female groups, females directed most of their interaction to males and showed lower achievement than males. In groups that were majority-male, females were ignored by males and showed somewhat lower achievement than did males. She had not purposely conducted single gender group studies, although, during the study some female

participants were absent which left single male groups. These groups were considered as all-male for the study analyses. Most groups had four members and one had five. Five groups had two females and two males, six groups had one female and several males, six groups had one male and several females, and three groups had only males due to female absenteeism. Junior high students from two above-average general math classes, taught by the same teacher participated in the study for two weeks. Approximately 43% of the 77 students were female; 57% were male. A 40 item test of mathematical reasoning ability was administered to all students at the beginning of the year for use in assigning students to classes. At the end of the study, a 20 item achievement test was given to the students in the study. Internal reliability for the ability test was .80; for the achievement test, it was .88. All groups had similar means on ability. Interaction among group members was tape recorded. Even though males and females had comparable ability, males outperformed females on the achievement test. Webb explained that this result may have been because of the greater success of males in obtaining explanations and information when they requested them. The females in the majority-male groups were often ignored even when they asked for help. Webb also noticed that females and males both tended to seek help from males more often than from females.

Another study was conducted in a white, middle class, rural area in Wisconsin (Peterson & Fennema, 1985). From January to April, six males and six females from 36 fourth grade classes (N = 432) were observed in math activities. They were given a National Assessment of Educational Progress Mathematics Achievement Test in December, before the study and again in May, after the study. Reliability of the test was assessed using Cronbach's alpha coefficient of internal consistency. For high-level cognitive items reliability was assessed as .62 for the pretest and .68 for the posttest. For low-level congnitive items, reliability was assessed as .67 for the pretest and .68 for the posttest. The alphas appeared low but were considered adequate because of the diversity of the item content. The results indicated no significant difference in either math achievement or engagement/nonengagement in math activities. Four types of activities were consistently and differentially related to girls' versus boys' low and high level math achievement; social activities, off-task behavior, competitive activities, and cooperative activities. For the girls, the most important variable related to their achievement was cooperative rather than competitive activities.

All of these studies called for further investigation into why boys perform better than girls in math and offered suggestions to teachers that would help increase achievement and performance

of girls. The most consistent result was that girls perform better in cooperative groups.

Purpose

The purpose of this study was to investigate different grouping patterns such as mixed and single gender, homogeneous, random, and heterogeneous, and their effects on student academic achievement.

Method

Subjects

The sample consisted of 62 10th-12th grade students in two intact geometry classes from a suburban high school in Northern California. From the CAT tests it was determined that these, because of their parent(s) income, were middle to upper-middle class students. The students were tracked by the school into one of three regular (not basic or honors) geometry classes based on their prior math achievement scores. The population for Geometry A was 29 students: 27 white, 2 minority (Asian American, Mexican-American), 10 females, 19 males; the population for Geometry B was 33: 30 white, 3 minority (Mexican-American), 20 females, 13 males. Both classes were held in the morning for the same amount of time, used the same teacher, book, and materials, and were given the same tests on the same days.

The teacher had six years experience, was male, and usually used random selection method when grouping students for cooperative group work. Working cooperatively was defined to the students as each doing an equal share of the work and each helping other group members learn the material and complete the assignments.

Instruments

The pretests were designed by the teacher and given to both classes before instruction of the material. A total of six pretests were given. The posttests were nearly identical to the pretests except that numbers were changed to prevent memorization of pretest material and were administered at the close of each topic. A total of six posttests were given.

Four teacher-made quizzes and one teacher-made chapter test relating to the material covered during the study were used to help form the groups. It should be noted that the textbook's standardized tests were not designed to evaluate student performance on single-topic sections and therefore were not used for this study. The aim of this study was not to measure the quality of the test but to measure student improvement.

Procedures

The teacher selected six second-semester geometry topics from the text that involved the same basic skills, namely, using right triangle trigonometry, 30-60-90 and 45-45-90 degree triangles to solve two- and three-dimensional figures. The teacher then spent two weeks covering background material students would need to know before beginning the six sections. He administered four quizzes and a chapter test to evaluate students' achievement on the background material. A schedule was devised to correlate the six different topic sections with five different grouping patterns; heterogeneous, homogeneous, random, single gender, and mixed gender. Definitions of terms (cooperative learning, heterogeneous, homogeneous, geometry topics) were discussed, as were ways in which to group randomly, individual student accountability strategies, the teacher's role of facilitator and observer, student response sheet, and group reward possibilities.

The length of the study was ten weeks including the two weeks of background information and testing. Students remained in each grouping pattern for an average of four days and took each pretest and posttest individually. The pretest and posttests were given to both classes on the same days for the same amount of time.

Assignment of Students to Groups

Group composition was determined on the basis of achievement scores on quizzes and a chapter test. Three ability strata were defined--high, medium, and low--corresponding to the top 25%, the middle 50%, and the bottom 25% of the sample. Geometry A ended up with six groups of four students and one group of five students for each grouping pattern. Geometry B had seven groups of four students and one group of five students for each grouping pattern. The one exception was for single gender groups: Geometry A had two groups of five girls and four groups of four boys with one group of five boys; Geometry B had five groups of four girls and two groups of four boys with one group of five boys. The schedule for grouping was as follows:

Topic	Geometry A	Geometry B
1	Heterogeneous	Random
2	Random	Heterogeneous
3	Single Gender	Mixed Gender
4	Mixed Gender	Single Gender
5	Homogeneous	Heterogeneous
6	Heterogeneous	Homogeneous

Student Accountability and Group Reward

Two techniques were used to ensure student accountability (every student is learning the material). The students were informed that for the first five minutes of class, one group member would be selected at random to go to the board and work on a problem, also selected at random, from the previous assignment. Each student from every group selected a slip of paper from a "hat", but only the student with the marked slip was required to work a problem. That student chose another slip of paper from another "hat" which had written on it the number of the problem to be completed. Another technique used was to assign each member in every group a problem from the previous assignment. At the end of five minutes the group's four problems were checked by the teacher. If all were completed correctly, each member of the group was given four bonus points. The classes decided that if the class average on posttests was above 75 percent, each student would receive bonus points.

Teacher Observation and Student Response Sheet

The teacher made brief observation notes on group interactions, number of times he was used as a resource in class, general comparisons between classes, and peculiarities of grouping patterns. At the end of the study, students were given a list of all the groups they had been in and the topic covered while in those groups.

TABLE 1

Means, Standard Deviations, and t Tests of Achievement between Groups

Grouping Patterns and t tests*	n	Pretests M	Pretests SD	Posttests M	Posttests SD
Heterogeneous$_A$	24	5.21	2.98	28.83	9.41
Random$_B$	28	6.42	5.05	29.46	8.05
t test		1.03		0.26	
Random$_A$	24	7.17	13.05	31.17	9.91
Heterogeneous$_B$	30	7.50	12.05	32.93	8.63
t test		0.93		0.70	
Single Gender$_A$	23	2.43	4.09	26.78	10.51
Mixed Gender$_B$	26	2.69	2.99	29.85	6.98
t test		0.26		1.22	
Mixed Gender$_A$	22	5.50	9.46	23.68	12.68
Single Gender$_B$	27	1.48	2.62	27.63	12.40
t test		2.11**		1.09	
Homogeneous$_A$	27	10.89	4.44	25.07	9.27
Heterogeneous$_B$	27	13.48	6.26	31.52	7.77
t test		1.75		2.77**	
Heterogeneous$_A$	25	11.56	14.09	25.64	11.45
Homogeneous$_B$	23	8.61	11.44	29.65	12.60
t test		0.79		1.15	

Note. Subscripts A, B denote Geometry classes A and B, respectively.

*All t tests at $p < .05$. **significant difference found.

They were asked to circle the group in which they learned the most and state why. They were also asked to indicate the group in which they learned the least and why: Were they with people they liked? Was the topic easy for them? Did someone in the group help them to better understand the topic?

Results

The means and standard deviations for pretests and posttests taken by Geometry A and Geometry B classes in various grouping patterns appear in Table 1. The selected significance level was p .05 and the t test was used to compare the achievement levels of the different grouping patterns. These results also appear in Table 1. The number of students differed for each grouping pattern because only those students who took both pretest and posttest and who were present for the entire group assignment were included. Geometry B had three to six more students than Geometry A for all except the final two grouping patterns.

The means and standard deviations on the pretests and posttests were not significantly different for the heterogeneous and random grouping patterns. The t test indicated significant differences for only two different grouping patterns; the fourth pretest taken

before Geometry A was grouped by mixed gender and Geometry B was grouped by single gender, and the fifth posttest taken after Geometry A was grouped homogeneously and Geometry B heterogeneously. The t test for the fifth pretest showed no significant difference at a p .05 level but did at a p .10 level.

The means for Geometry B were higher than the means for Geometry A on all pretests except the fourth, which showed significant difference, and the sixth, which did not show significant difference. The means on all posttests were higher for Geometry B than for Geometry A. The standard deviation between the classes did not differ dramatically except during the gender groupings on the third posttest scores and the fourth pretest scores.

Teacher Observations

The groups that worked best together were those groups in which some of the members were friends a[illegible]/or one [illegible] the members was one of the brighter students in the class. The girls were more communicative than boys in groups unless they were the only girl in the group. The groups which needed more teacher assistance were the low homogeneous groups and the random groups which happened to have low students. The level of teacher assistence was also highest on the most difficult topic. The lowest level of teacher assistance was needed for the topic that both classes enjoyed the

most and did the best on, in terms of class mean. The teacher had difficulty in convincing only one student to participate in group work. All the other students preferred to work in groups rather than work alone and most wanted to select their own groups. The higher level students expressed enthusiasm about helping middle and lower level classmates, while some lower level students expressed a preference for their peers' explanations to those of the teacher.

Student Responses

Table 2 summarizes the student response sheets. One student from Geometry A did not pick a group in which he learned the most or the least because he said he learned and worked well in all the groups. His responses were not included in Table 2. The most noticeable results, when looking at the total column, are the responses to single gender and homogeneous grouping pattern. Nineteen students favored single gender grouping, fifteen were from the same class. Only 3 students out of 57 learned the most in homogeneous groups. These were two high ability students and one average ability student. Of the ten who disliked homogeneous grouping, seven were low ability students, two were high, and one was average.

For Geometry A, the greatest difference between the pretest and posttest mean was for single gender groups, the pattern selected

by many students in that class as the group in which they learned the most. The least difference between the pre- and posttest means occurred for the homogeneous grouping and the last heterogeneous grouping. Ten students indicated they learned the least in these groups. Mixed gender grouping had the overall lowest posttest mean and was least favored by seven of the Geometry A students. Of the seven students who said they learned the least in mixed gender groups, six were ones who said they learned the most in single gender groups.

For Geometry B, the greatest difference between the pretest and posttest mean was for mixed and single gender groups. Only four students indicated they learned the most in single gender groups, while five indicated they learned the least. Six students said they learned the most in mixed gender while four said they learned the least. Only one student who favored single gender grouping indicated that he learned less in mixed gender groups. One girl said she learned less in the single gender group but the random group in which she said she learned the most happened to be an all girl group. The least difference between the pre- and posttest means occurred for the final heterogeneous grouping, although the mean was one of the highest, overall. The highest overall mean was for the first heterogeneous grouping; the lowest was for the single gender grouping.

TABLE 2

Summary of Student Response Sheets

Grouping Pattern	Geometry A Learned Most	Geometry A Learned Least	Geometry B Learned Most	Geometry B Learned Least	Total Most	Total Least
Heterogeneous	4	2	5	9	9	11
Random	4	3	9	8	13	11
Single Gender	15	3	4	5	19	8
Mixed Gender	1	7	6	4	7	11
Homogeneous	1	6	2	4	3	10
Heterogeneous	1	4	5	1	6	5
Total	26	25*	31	31	57	56

Note. Geometry A student said no one group made him deficient.

Reasons Given by Students for Learning the Most or Least.

Heterogeneous Groups

Most: One or all members knew what they were doing.

All group members were helpful.

One member helped others to understand the problems.

Everyone worked together.

Group members were all friends.

Least: One member was gone the whole time.

Some members did not do anything or one did all the work.

One member disliked other members.

Group was easily distracted and did not stay on task.

Random Groups

Most: All members made sure answers were correct.

All members helped each other understand the work.

All group members knew a lot.

Topic was easy.

Least: No group member knew what he/she was doing.

Group did not work well together--no communication.

One member did all the work or one did not do any.

Not enough group members.

Single Gender Groups

Most: Members were organized--each took a section, learned it, and taught it to the others.

Member was able to help other group members and in the process, learned more.

Members were not embarrassed to ask questions.

Least: Selfish members--did only problems they wanted to do.

Group members talked too much--did not want to work.

One member absent too much.

One member did not like other members.

Some members received no help when asked--felt ignored.

Mixed Gender Groups

Most: Members explained problems to each other.

Liked the group members.

Least: Members were not organized.

Members were all friends and did not work.

Some members felt embarrassed to ask questions.

Some members did not receive help when asked.

Homogeneous Groups

Most: Members were quiet and hardworking.

The topic was easy.

Other members did not need help--each was able to work alone.

All members knew what they were doing.

Least: Members did not want to work together.

Members fooled around.

No member knew how to do anything.

Discussion

From the results of the heterogeneous and random groupings it would seem that, for math achievement, one is not better than the other. The means were similar as was the range of improvement between the two classes. This might have been due to the heterogeneous nature of the random groups.

The results of the gender grouping showed significant difference in one pretest. The standard deviation in relation to the class mean for this pretest was unusually high. Three students in Geometry A studied ahead for the pretest and scored high while the other students scored very low. This could account for the wide dispersion of scores. On this pretest, the range of scores for Geometry A was 36, whereas the range of scores for Geometry B was 10. Geometry B students did better than Geometry A students on the posttests but whether this because they were grouped by gender is questionable. Geometry A when grouped by gender did not perform any better than Geometry B, although they did not perform any worse.

The results of the comparison between heterogeneous and homogeneous groupings had one posttest which showed significant difference. The pretest also showed significant difference but at a p. 10 level. Both classes had the same number of students

and the difference in the posttest means was significant. Geometry B was grouped heterogeneously and therefore had one high level student in each group. Geometry A was grouped homogeneously and many of the students scored very low which also lowered the class mean.

However, when Geometry A was grouped heterogeneously the expectations were that their posttest mean would be higher than homogeneously grouped Geometry B. But the homogeneous group's posttest mean was higher. The difference in the improvements of the pre- and posttest means might have been caused by the absence of eight Geometry B students. Five of these students were average, two low, and one high. Their posttest results might have lowered the mean had they taken it.

Other factors which may have influenced the results are: length of class period, time of day, quality and content of instruction, differences between the class populations. Geometry A was the first class of the day and the class period was six minutes shorter than Geometry B's class because of the morning bulletin. There were also problems with tardiness and lack of attention. The teacher felt he was more prepared and gave clearer lectures for Geometry B after having taught Geometry A. There were more average students in Geometry B than in Geometry A but more low students in Geometry A than in Geometry B. The number of high students was similar for both classes. This might

explain why Geometry B's posttest mean was always higher. The ratio for girls to boys was higher for Geometry B than for Geometry A and Geometry A was the class that preferred single gender grouping. Students changed groups when a new topic was introduced and it might be more valid to have them remain in one grouping pattern for a longer period of time.

From the results of this study, it would appear that grouping heterogeneously or randomly makes no difference. Most students seemed to prefer and perform well in single gender groups. The homogeneous grouping pattern showed the least improvement of difference between the pre- and posttest means and many students felt they learned the least in these groups. No one grouping pattern seemed to significantly improve student achievement more than others. Teachers need to consider other factors, their own teaching philosophy, and the benefits and consequences before grouping heterogeneously, homogeneously, by random, or by gender.

Further Research

The focus for further research in cooperative grouping includes concentration on the following areas; comparison of other grouping patterns and their effects on achievement, the influence of other

dynamic variables, and the influence of the teacher on the success of the grouping.

One grouping pattern to consider when researching is self-selected grouping where students choose their own groups. Dynamic variables are ones that can be changed or influenced. For cooperative learning, studies on the influence of content areas and on how a teacher grouped students would be especially important. Some educators group heterogeneously if the content involves higher level problem solving skills or combine homogeneous with heterogeneous grouping when the content involves basic skill concepts. Other educators group differently for math than for reading; and some choose not to group for some content areas but do for others. Other dynamic variables that merit investigating are motivation--group/individual reward systems, specific patterns of behavior in group interaction, and the influence of peer liking or peer pressure on group behavior and success.

One last area that needs more research due to conflicting and varying studies that now exist is gender grouping. The possible causes, if any, of observed gender differences in math achievement and conclusive evidence that cooperative learning improves the achievement levels of girl would be helpful guides for teachers when grouping cooperatively.

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